

Title: Expansion of Ecological Monitoring in North Biscayne Bay with a Focus on the Role of Nutrient Dynamics in Recent Seagrass Losses

Proposal Narrative:

1. Introduction for Addressing the Priority Action Items

a. Situation, Need, and Previous Efforts –

Biscayne Bay covers 428 mi², the largest historical estuary in southeast Florida. With alterations to the natural freshwater sheetflow, the estuary has increased in salinity from historical levels. But, the bay still relies heavily on its freshwater inputs that are primarily through canals producing pulsed discharges of freshwater, currently as a managed component of the Comprehensive Everglades Restoration Project by the South Florida Water Management District (SFWMD).

Biscayne Bay Aquatic Preserves (BBAP) were enacted in 1974 and 1975 by the Florida legislature as defined by Florida Statute 258.397 and Chapter 18-18, Florida Administrative Code (F.A.C.). BBAP was established for the purpose of “preserving and enhancing Biscayne Bay...in an essentially natural condition so that its biological and aesthetic values may endure for the enjoyment of future generations”. BBAP is unique in its designation in that its rule and statute are separate and more stringent than the other 39 Florida Aquatic Preserves regulations. In addition, Biscayne Bay is defined as worthy of special protection designation and classification as an Outstanding Florida Water (Chapter 62-302, F.A.C.) because of its natural attributes. This additional designation protects existing water quality from further degradation by discharges, lower water treatment levels, and requires public interest component adherence.

The two state aquatic preserves of BBAP, the Biscayne Bay Aquatic Preserve and the Cape FL to Monroe County Line Aquatic Preserve, make up 68,771 acres of submerged lands including seagrass beds, hard bottom, sand and muddy bottom, natural and spoil-made islands, and mangrove forests. The natural mainland tributaries are included within BBAP up to their headwaters (Oleta River) or up to their salinity control structures (Miami River, Little River, etc.). The Biscayne Bay Aquatic Preserve overlaps with the Florida Keys National Marine Sanctuary in the Card Sound and Little Card Sound areas. In order to define management actions, a 10-year BBAP Management Plan was created to cover 2012-2022 [1].

Submerged aquatic vegetation, provides irreplaceable economically and ecologically important services to the aquatic environment. These services are not limited to providing habitats for a variety of wildlife, stabilizing sediments, maintaining good water quality, and cycling nutrients. By serving as a nursery, seagrasses provide critical habitat necessary for many fish and invertebrate species to complete their life cycles. Many species of commercially and recreationally important fish are life-stage dependent on seagrass beds located within Biscayne Bay. Within a seagrass bed, blades work to reduce wave-energy within shallow subtidal zones and promote the settling of suspended particles. Root structures contribute by preventing erosion and stabilizing sediments, resulting in the maintenance of water quality conditions. Seagrasses are reliant on their ability to

photosynthesize effectively, a metabolic action which oxygenates the water column and leads to better habitats for fish and invertebrate populations. Seagrasses also provide critical foraging habitats for several species of predators, including wading birds, large species of fish, who are reliant on the nursery for fish, crustaceans, and other marine species for food and are an important source of food for threatened species, like manatees and sea turtles [1], [2].

Seagrasses are incredibly vulnerable to human activity. One of the most important factors that influences seagrass growth is the amount of solar radiation reaching the leaf blades, as turbidity can block the light amount necessary for photosynthesis. As seagrass loss occurs, indirect effects on the environment can include sediment re-suspension and nutrient loading within the water column from an increase in nutrient fluxes from sediments. Once damage has occurred within a seagrass bed, it can be repeatedly damaged by the continual resuspension of sediment and degradation of water clarity [3].

Eutrophication in aquatic systems can impact algal growth. Increased nutrient loads in aquatic systems can be a result of anthropogenic nutrient sources. Excess nitrogen and phosphorous in the water column can cause algae to grow at a faster rate than ecosystems are able to cope with [4]. An overproduction of algae within the ecosystem can be harmful to seagrass beds. Seagrass decline, due to high nutrient loads, typically leads to an increase of macroalgae or phytoplankton [3]. Rapidly growing epiphytes and macroalgae both have the ability to outcompete seagrass and will reduce the light availability necessary for seagrass photosynthesis [3].

A north Biscayne Bay seagrass die off, along with recent Harmful Algal Blooms (HAB) in north bay, have led to declines from 66-89% of seagrass coverage within BBAP [2]. A recent loss event resulted in the creation of a BBAP continuous assessment program in the Julia Tuttle Basin, where the die off is centralized. BBAP staff are focused on documenting and understanding seagrass losses reported in Northern Biscayne Bay, particularly in the Julia Tuttle Basin. Prior work undertaken by other institutions shows a significant increase over time in nutrients and chlorophyll-a in the water column in this area. BBAP's project aims to elucidate the relationship between water quality and benthic species composition. This research has three major components: benthic monitoring, water quality grab samples, and long-term deployment of datasondes. Sites sampled historically by other projects were prioritized and therefore long-term data are available for some sites. Current sampling began for benthic assessments in 2018 and for water quality monitoring in 2019.

The benthic monitoring is focused in areas where seagrass is still present or in areas of recent loss. The benthic assessments include quadrat surveys for species composition and abundance, photographing site status, measuring canopy height, characterizing sediment type, measuring sediment depth, and taking tissue samples of all seagrass species present at a site along with a subset of macroalgal species, focusing on *Halimeda spp.* Tissues are analyzed for carbon, nitrogen, and phosphorous elemental composition; carbon, nitrogen, and sulfur stable isotopes; seagrass leaf morphometrics; seagrass biomass; and seagrass epiphyte biomass. The water quality grab monitoring stations overlap with some of the benthic monitoring locations, but also include sites

in nearshore areas and canal mouths to assess the sourcing of nutrients and other pollutants. The parameters collected in the grab samples are chlorophyll-a, organic carbon, dissolved organic carbon, total suspended solids, ammonia, Kjeldahl nitrogen, nitrate-nitrite, total phosphorous, and 23 chemical, pharmaceutical, and pesticide tracers. Our three datasonde stations are situated in an array from the river suspected to be a major source of pollution in the area through the basin's seagrass habitat. There is one datasonde in the Little River, one in the northwest section of the Tuttle shoal where the seagrass loss occurred relatively early and is now dominated by a dense bed of *Halimeda discoidea*, and one in the southeast section of the Tuttle shoal where the loss occurred most recently and where some sparse seagrass remains (Figure 3).

Preliminary analysis of the data from this project support the hypothesis that eutrophication has occurred in Northern Biscayne Bay. The high density, long leaf length, epiphyte laden *Syringodium filiforme* that dominated the system prior to the die-off is indicative of nutrient loading. Our data indicates that nutrient loading is occurring and that anthropogenic nutrient inputs are reflected in plant tissues. Nearshore sites have greater nutrient loading, especially associated with the Little River. Multiple other research projects have looked at the relationship between canals and water quality in Biscayne Bay and findings have consistently shown high nutrient loading in canals has led to high nutrient zones in the adjacent bay.

b. Objectives –

Increasing monitoring to areas where large seagrass losses have not yet occurred would allow for an important comparison of seagrass die off areas currently being researched, while also allowing BBAP to capture baseline data prior to any potential future losses. Additionally, indicators such as changes in the stable isotopes or elemental composition of plant tissues, benthic species composition, or epiphyte loads may allow BBAP to identify areas affected by stressors prior to an ecosystem collapse. Potentially identifying areas undergoing eutrophication prior to loss could allow for targeted mitigation of water quality in specific areas, reducing stressors in the system before resources are lost. Early action could be especially impactful due to negative feedback cycles, as the loss of sediment stabilization following a die off can create an alternate stable state in which regrowth is difficult.

This project's goals would add three datasonde stations at the border of the Biscayne Bay Aquatic Preserve, in connection with the Miami Canal coming south directly from Lake Okeechobee. Upon entering Miami-Dade County, the Miami River becomes the C-6 with an offshoot of the waterway becoming the Little River Canal, the C-7 (Figure 3). At the mouth of the Little River lies the Julia Tuttle Basin, the central site of a 1,300-acre seagrass die off that initiated around 2012 [2]. Since 2018, BBAP staff have responded to the die off with a water quality (datasonde deployment and monthly water grab sampling) and seagrass assessment program across the Julia Tuttle Basin and the adjacent water inputs.

This effort would be in concert with monthly water quality grab sampling, quarterly benthic habitat assessments, and quarterly tissue sampling that would be funded by BBAP. Analysis of water quality grab samples is conducted by Florida's Division of Environmental Assessment and

Restoration (DEAR). Tissue sampling and isotopic analysis is contracted to Florida International University (FIU). With an expanded monitoring program, BBAP would develop monthly water quality grab sites and tissue sampling sites in the Miami River associated Rickenbacker Basin. Additional parameters may be sampled if time and funding allow.

Partner coordination for this program expansion would include continued work with Miami Dade County's Department of Environmental Resource Monitoring (DERM) & Water and Sewer Department to develop a more comprehensive, multiagency, bay wide nutrient and bacteria sampling effort. This expansion would add to the existing effort that currently works with DERM, FIU, and DEAR. Florida Sea Grant has agreed to assist the project with field work support and increasing stakeholder outreach and education to the region.

We predict that precipitation events and water releases will be linked to increased nutrient loading in canals and in adjacent areas of Biscayne Bay. Nutrient increases are expected to lead to increased phytoplankton, seagrass epiphytes, and macroalgal blooms. We predict that seagrasses and macroalgae closest to major freshwater sources (channelized rivers) will show the highest amount of anthropogenic nutrient loading in their tissues and may also be the most at risk for future seagrass losses.

c. Applications, Benefits, and Importance –

The Southeast Florida Coral Reef Initiative (SEFCRI) Local Action Strategies specific multiple objectives related to this project's goals:

- Issue 1, Objective 2 by establishing water quality monitoring project to establish status and trends in Miami Dade County.
- Issue 2, Objective 1 by identifying levels of contributions of point sources.
- Issue 5, Objective 1 by increasing public awareness towards land-based sources of pollution and their effects on water quality. [5]

Also, the BBAP Manager is a SEFCRI Team Member.

The importance of this application is further supported by Executive Order 19-12 of Governor DeSantis, which direct Department of Environmental Protection (DEP) staff to focus on improving water quality and preserve natural resources.

2. Methods and Approach

d. Description of Major Tasks –

1. Hiring of a new Water Quality Specialist and Analyst position, purchasing of the YSI EXO 2 datasondes and probes, creation of the datasonde mounts
2. Deployment testing (in-water) of the datasondes, new site establishment
3. Data collection, QA/QC, and analysis – software including PRIMER, ArcGIS, R, and Excel. Statistical testing including linear regression, trend analysis, and multivariate analysis. Multi-step QA/QC processes will occur for all data collected including an initial QA check to ensure data passes DEP continuous calibration verification, along with a secondary and tertiary check using the standard procedures from the 'YSI/Xylem EXO Multi-Parameter Water Quality Monitoring Standard Operating Procedure'. Data that does not pass the verification process will be flagged

and not used in the report. Data will be uploaded into the datasonde portal and Statewide Ecosystem Assessment of Coastal and Aquatic Resources (SEACAR) website for public access.

4. Report writing

5. Presenting of information to the public, including uploading to publicly available repositories

e. Environmental Impact – Environmental impacts to the project will be minimized and will include appropriate permitting, as needed. Datasondes deployed up the rivers will be mounted via a PVC housing vertically attached to a dock or piling (Figure 1). Any datasondes deployed horizontally at the bay or river bottom will be attached to a concrete platform no larger than 3ft² (Figure 2). Any potential taking of seagrass and algae for tissue sampling will occur via inclusion on an existing Florida Fish and Wildlife Conservation Commission Special Activity License (SAL-18-2001-SR) which allows for the collection of marine organisms for scientific research purposes pursuant to 68B-8, F.A.C.

f. Future Efforts – This will be a multi-year project that will include results used to inform targeted management actions for restoration and/or mitigation efforts. Education and outreach initiatives will extend to local, state, federal, non-profit, and academic partners that will have public access to the project's data for any additional statistical analysis opportunities.

3. Project Management

g. Administration - The PI is responsible for directing the work effort, reporting, procurement, and data collection. The regional business office manager will be responsible for the accounting, billing, and financial records for the grant. The DEP Office of Resilience and Coastal Protection (RCP) Deputy Director, Rebecca Prado, will be the signing authority for this grant.

h. Roles/Assignments and Participation Time -

Laura Eldredge – BBAP Manager. Field days include 0-6 days a month depending on sampling effort. Claire Burgett – Spatial Ecology Coordinator. Field days include 2-10 days a month depending on sampling effort; GIS assistance; statistical assistance; datasonde training. Sarah Gumbleton – Environmental Programs Coordinator. Field days include 2-10 days a month depending on sampling effort; field planning; education and outreach. Further information on staff responsibilities can be found in Attachment 1. Kathryn Petrinec – Research Assistant. QA/QC of datasonde data and uploading into SEACAR portal and the RCP continuous water quality data portal.

4. Support Requirements and Conditions

i. Cooperation from Other Organizations – A permitting process will occur with Miami Dade County, the SFWMD, and the Army Corps of Engineers.

j. Date or Facility Access – Data will be maintained by DEP and publicly accessible through the SEACAR Data Discovery site <https://dev.seacar.waterinstitute.usf.edu/> and RCP's continuous water quality data portal <https://www.floridaapdata.org/>. Data can also be accessed by public request.

5. Results/Outputs Deliverables

k. Bi-Annual Reports - The principal investigator shall provide bi-annual progress reports to the Project Officer on March 30th and September 30th of each year. These reports will consist of updates on progress toward work objectives, justification, approach, results to date, any problems encountered, actions taken to resolve problems, discussion of remaining tasks, and expenditures to date.

l. Final Report – The PI shall prepare a draft final report summarizing the objectives, methods, approach, results, and significance of the study along with potential management actions. The draft final report will be reviewed by the Project Officer and returned with comments. The principal investigator will address the comments and submit the final report with revisions. The final report will be due within six months of the completion of the project.

m. Deliverable Items and Schedule – A bi-annual progress report (in docx format) will be delivered on March 30, 2020; September 30, 2020; March 30, 2021; September 30, 2021; March 30, 2022; September 30, 2022. On December 31, 2022, a draft version of Final report (docx) will be due and on March 30, 2023 a Final report (docx) will be due with any finalized versions of any of the specified outputs defined in section n. Outputs.

6. Environmental Results –

n. Outputs (products) - Bi-annual and draft/final reports documenting applicable methods, qualitative analysis, raw data, photographs of and any presentations or outreach products produced, including stakeholder engagement numbers. Deliverables may also include best management plans, standard operating procedures, and QA/QC processes as may be defined for the project.

Outcomes (objectives) - The scope of this project is in line with the EPA's Objective 1.2: Provide for Clean and Safe Water, specifically the directive to partnership with states to maintain, restore, and improve water quality. Data collected from this research project will be beneficial in developing recommended water quality criteria and for developing programs to protect and improve water quality in estuarine areas. By increasing water quality monitoring within the bay, this allows for the state to continue to make progress in making waterbodies safer for swimming and boating activities.

This project also meets Goal 2 Objective 2 by increasing the transparency of the continuous water quality monitoring data as uploaded and made publicly available through the recent creation of DEP's RCP datasonde portal – <https://www.floridaapdata.org> and the SEACAR Data Discovery database - <https://dev.seacar.waterinstitute.usf.edu/>. All data will be publicly accessible. Dissemination of the data reports will occur via public presentations at partner and coordination team meetings, workshops, conferences and general speaking requests throughout the state.

By strengthening partnerships with the state and local entities by presenting data and outputs from this project to develop greater scientific and technological solutions to meet water quality criteria thresholds, Goal 3 Objective 3 can be met. These partnerships are currently in existence but would increase with enhanced stakeholder engagement and more defined knowledge of pollution sources, allowing for targeted discussions with local authorities.

o. Tracking – Tracking of outputs will include spreadsheets and documents listing stakeholder engagement events and numbers, reports of water quality analysis results from partners, dates of field work, and bi-annual reports with cumulative summaries of each outcome to date. Tracking of objectives will include analyses to help direct implementation of potential water quality goals, successful progress within BBAPs management plan identified strategies, and continual uploading of project data to the publicly accessible data portal.

7. Literature Cited –

- [1] Florida Department of Environmental Protection. 2012. Management Plan for Biscayne Bay Aquatic Preserves, Florida Coastal Office, 212 pp
- [2] Miami-Dade County Department of Regulatory and Economic Resources. 2019. Report on the findings of the County’s study on the decline of seagrass and hardbottom habitat in Biscayne Bay, 27 pp
- [3] Burkholder, J.M., Tomasko, D.A., Touchette, B.W., 2017. Seagrasses and eutrophication. Journal of Experimental Marine Biology and Ecology 350, 46-72
- [4] Environmental Protection Agency. 2019. Nutrient Pollution. Retrieved from <https://www.epa.gov/nutrientpollution/issue>
- [5] Florida Department of Environmental Protection. 2004. Southeast Florida Coral Reef Initiative: A Local Action Strategy. Retrieved from https://floridadep.gov/sites/default/files/SEFCRI_LAS_FINAL_20May05.pdf

8. Budget Summary:

Budget Category	EPA Funds Yr1	EPA Funds Yr2	EPA Funds Yr3
Salaries	38,000	38,000	38,000
Fringe Benefits (FICA at .0145 plus Healthcare at 8,500/yr)	9,051	9,051	9,051
Travel			
Equipment	97,600		
Supplies	3,000	3,000	1,270
Contractual Costs			
Other Direct Costs			
Indirect Costs (at 20.53%)	9,659	9,659	9,659
Total EPA Funding	275,000		

Budget Narrative:

EPA funds would be used to add three continuous water quality monitoring sites, thereby doubling the current continuous monitoring project extent. This would require five YSI EXO 2 datasondes with probes and maintenance, totaling \$19,520 each. Supplies totaling \$7,270 over three years would be for datasonde calibration standards (turbidity, conductivity, and pH) and in-water mount pieces (PVC, concrete, hardware, etc.). One new full-time OPS Water Quality Specialist and Analyst position (reporting to BBAP manager) would run the program logistics, sampling, and analysis. Adding someone to our team who can make deeper inferences from data would increase

our ability to make targeted management decisions. Any expansion of the current monitoring program would require another position to assist with monitoring, datasonde calibration and deployment, and analysis at a per year rate of salary of \$38,000, fringe benefits of \$9,051, and indirect of \$9,659. The value of the indirect costs will remain for the life of the grant at 20.53%.

Figures 1 & 2: Vertically mounted datasonde deployment in the Little River. Horizontally mounted datasonde within the Julia Tuttle Basin with associated submerged marker buoy.

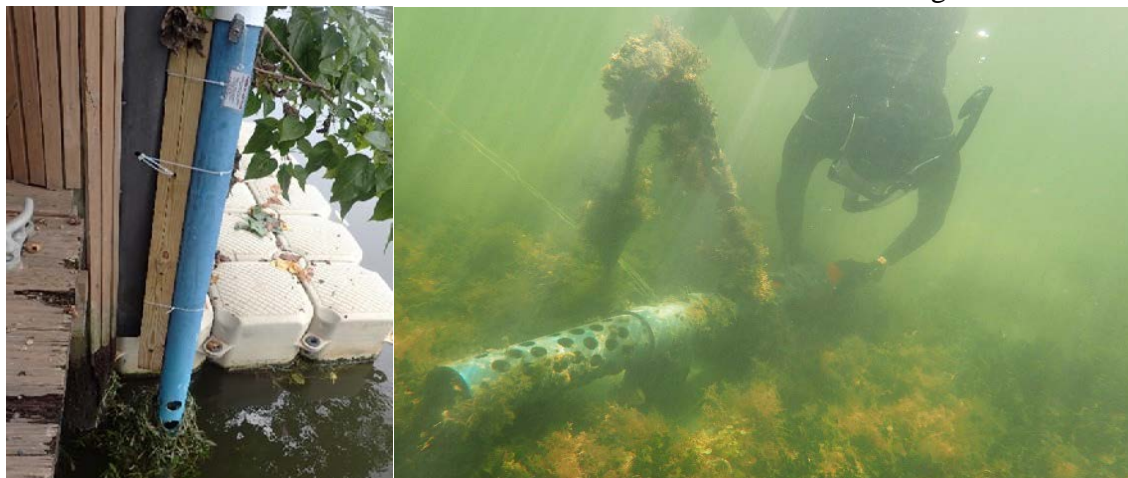


Figure 3: Map of Biscayne Bay Aquatic Preserves, the associated upland canals providing inputs, current datasonde deployment sites, and proposed additional datasonde deployment sites.

